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AMERCAN FOUNDRYMENS' ASSOCIATION.

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The American Foundrymens' Association is not responsible for any statement or opinion that may be advanced by any contributor to this Journal.

PROCEEDINGS OF THE PHILADELPHIA FOUNDRYMEN'S ASSOCIATION.

The regular monthly meeting of the Foundrymen's Association was held at the Manufacturers' Club, Philadelphia, on Wednesday, December 7, the President, P. D. Wanner, occupying the chair.

The report of the Executive Committee referred to the death of Thomas Glover, of the firm of Glover Brothers, Frankford, a member of the association and a member of the Executive Committee since the formation of the association in 1891. In regard to the foundry trade the committee report stated: "Until five or ten years ago foundry engineers were sent to this country from the old world to teach the ways and means of making perfect and clean castings for the least cost, and to introduce methods and appliances which they considered better than were in use here. The tables seem to have been turned now. Foundry practice in this country has developed to such an extent that it is considered ahead of the times, and in consequence there have been many inquiries recently from the other side of the water for our improved appliances and equipment."

J. H. Mueller, of the Hy. McShane Mfg. Company, and John

S. Kennedy, of the Sheridan Iron Company, Sheridan, Pa., were elected to membership in the association.

The Treasurer reported a good balance in hand and all bills paid.

The subject, "Who is responsible for loss of customers' patterns in the case of a fire in foundry buildings?" was next brought up for discussion.

A. W. Goodell: I should like to hear from members as to what is their practice in regard to the insurance of patterns in the foundry. In the experience of my firm, covering over 40 years, we have never lost ten dollars on patterns and have never carried any insurance on our customers' patterns. We have always considered that it was their duty to carry the insurance. One of our customers wanted us to insure his patterns, but we would not consider the question at all. I should like to know what has been the custom in other foundries. As far as I know it has been the same as ours.

Josiah Thompson: We have just had a fire in our foundry, and it was not our first fire. This time we had patterns belonging to a customer burned. The owner wanted to know what we were going to do in the matter. We had orders for work from these patterns, and the customer said he would not furnish the patterns again unless we gave him an order. We finally gave him the order and included the cost in our insurance as patterns burned. He expected us to replace those patterns or lose his trade. There was a loss of time to both parties concerned.

The Chairman: As an attorney I might say that a foundryman to whom patterns are brought is not expected or should not be called upon to exercise more than ordinary care. I do not think the foundryman should be expected to insure those patterns at his own expense. All he is expected to do is to use ordinary care. If a fire occurs and patterns are burned, and negligence or carelessness can be proved, I think the foundryman would be responsible, but in no other case. That would be my view from a legal standpoint.

Mr. Goodell: Is it customary for foundrymen as a general thing to carry insurance on patterns?

The Chairman: I have never known it to be asked. I think when a man sends his patterns away he must run the risk or insure them himself. All he can ask or expect is reasonable care.

Mr. Thompson: I might mention a case where a customer carried insurance on his patterns at our place, and recently came over to overhaul them. He discarded some worthless patterns on which he had been carrying insurance for 10 or 12 years. These patterns were occupying the best part of our pattern room. Some of them were too heavy to carry back and forth when castings were required, so we had to store them.

Mr. Evans: A foundryman in this room to-night told me he had in his possession all the patterns of a machine shop which have accumulated during many years. In case of fire it would cripple the machine shop to such an extent as to require a year for the duplication of the patterns. Under those circumstances is a foundryman liable for any portion of the loss of time or failure to produce castings when required?

The Chairman: Ordinary care is all that could be called for.

Stanley G. Flagg, Sr.: Would it not be imperative when a customer brings patterns to a foundry to ascertain whether they are to be insured or not?

The Chairman: I do not think so.

Mr. Flagg: Then it is not proper for the customer to ascertain whether the patterns are insured or not?

Mr. Wanner: Yes, it is an important thing to ascertain.

F. A. Riehle: Customers having patterns in our foundry should know whether we are insuring them or not. We might presume one thing and they another; therefore if foundries in this section of the country would have an understanding in the matter at the time of making a contract it might lead to a proper precedent for foundries in other sections. I think it is wise to receive nothing in the way of patterns until the question has been

noted in the contract. It would be easy to act harmoniously and have an understanding in all such cases.

Thos. F. Rankin: If, as our President remarked, the law requires that a man shall do the best he can in regard to the care of patterns, having done so should exonerate him from all blame. It seems to me a preposterous proposition that any man should consider when he takes patterns to a foundry and gets an ordinary price on castings, that the expense of insurance is included. When a man leaves his patterns at the foundry there comes, in my judgment, a clear case of carelessness on the part of the owner of the patterns, and I should ask him in such a case whether he had done all that was necessary on his part to insure those patterns. I do not believe one man in fifty getting castings from a foundry takes half as much care of his patterns as he expects others to have for them. It seems to me entirely out of reason for any one to suppose that he can leave patterns at a foundry promiscuously. The chances are that such a man would not know what patterns he had until a fire destroyed them, and then he would come on the foundryman for a loss.

The Chairman: That is a good statement of the case, and it is not necessary to go beyond it. If the custom was established of insuring those patterns you would soon be making it a matter of liability for all foundrymen. For that reason it would be dangerous to establish a precedent. Leave the matter where it is.

Mr. Thompson: We should have to put up storage sheds for patterns only used once and which might well be thrown away.

Mr Evans: Suppose we pass a resolution showing the sense of this meeting to be that all foundrymen doing work for customers should inquire as to whether or not it was expected that the foundryman would be held responsible for the patterns in case of fire. That would bring the matter to a head.

T. B. Harkins: It would be better to ignore the whole thing. Foundrymen should not be responsible for patterns. I have been in business 27 years, and we have a lot of stuff around the place

fit for nothing but firewood, yet in case of fire the owners of these patterns might send in a claim for their original value. I can only remember one case where a customer questioned us concerning fire loss. In that case we ignored responsibility.

Mr. Flagg: I don't think you could get insurance companies to insure the patterns. It is hard enough to get insurance on our own patterns.

Mr. Warner: Leave well enough alone, that is the best course. The discussion seems to have brought out that foundrymen do not consider themselves responsible for patterns except in so far as reasonable care goes, and they are bound to give that. If patterns are destroyed by fire in a foundry and it could be shown that the fire could have been averted, a liability would exist, but not otherwise.

Mr. Riehle: I will move this resolution:

"Resolved, That it is the sense of this meeting that foundrymen should not hold themselves responsible for the destruction, by fire or water, of patterns belonging to other parties, in any way whatever."

The motion was carried, and the discussion closed.

The President named a committee to frame a resolution in reference to the death of Mr. Glover, and appointed Thos. F. Rankin to the vacancy on the Executive Board.

The proceedings closed with an interesting talk by C. L. Prince, of the Camden Iron Works, Camden, N. J., on "Water Pipes, Past and Present." Mr. Prince showed 58 lantern slides, many of which covered different stages in the manufacture of the cast iron water pipes used at the present day.

PROCEEDINGS OF THE PITTSBURG FOUNDRYMEN'S ASSOCIATION.

The December meeting of the Pittsburg Foundrymen's Association was held Tuesday evening, December 27, with about 25 members in attendance. The paper of the evening was by Dr. Wm. B. Phillips on "Yard Grading of Pig Iron." There was a discussion, participated in by Dr. Moldenke, Dr. Phillips and Messrs. E. A. Kebler, I. W. Frank and J. S. Seaman. The opinion expressed by several members that action should be taken looking to greater uniformity in methods and standards of grading pig iron finally took form in a motion. It was generally agreed that chemistry should have a larger place in furnace grading and should be the basis on which iron is bought.

The resolution finally passed was in this form:

"Resolved, That the Pittsburg Foundrymen's Association recommends to the American Foundrymen's Association the adoption of standard methods of grading pig iron for foundry purposes, and that our representative be requested to bring this matter before the Executive Board for action."

The Pittsburg district's member of the Executive Committee is I W. Frank.

Following is Dr. Phillip's paper:

THE YARD GRADING OF PIG IRON.

By WM. B. PHILLIPS.

In a curious report made to the King of England, about 200 years ago, on the subject of the manufacture of pig iron, it was stated that there were then made three kinds of iron, to wit, in the original words: "The first sort is gray iron. The second sort is called motley iron, of which one part of the sows or pigs is gray, the other part is white intermixed. The third sort is called white iron; this is almost as white as bell metal, but in the furnace is least fined, and the most terrestrial." The author goes on to say: "I may take occasion here to speak of the nature of cold-share iron, which is so brittle if made of the grain ore, or

iron stone would be almost as brittle as some regulus antimonii, made with iron, for with one small blow over an anvil you may break the biggest bar of it, if it be a perfect cold-share iron—nay, the ploughman often breaks his share-point off, if it be made of cold-share iron; but perfect tough malleable iron will not break feasibly in hot or cold, as cold-share iron will, or red hot as sulphurous red-share iron will, but yet tough enough when cold; all of which aforesaid qualities of iron the author well knoweth how to mend their natures, by fining or setting the finery less transhaw more burrow, which are terms of art, and by altering and pitching the works and plates, the fore-spirit plate, the truiron bottom, back and breast or fore plate, by the altering of which much may be done, if the work be set transhaw and transiring from the blast; the iron is more cold-share, less fined, more to the master's profit, less profitable to him that makes it into manufacturage, and less profitable to him that useth it, but the iron made in a burrow work becometh more tough and serviceable. Yet the nature of all iron-stone is to be considered both in the furnace and in the finery; the sulphureous, arsenical and veneriating qualities, which are oftentimes in iron-stone, to be made to separate in both the works from the fixed and fixing bodies of iron, whose fiery quality is such that he will sooner self-calcine than separate from any sulphureous veneriated quality."

This, gentlemen, is one of the earliest attempts to grade pig iron on the yard. It was in the time of Charles I. and Oliver Cromwell and passed as the most scientific description that had yet appeared. Since that day we have drawn away from the arsenical, veneriating quality of pig iron and have substituted cold-short for cold-share iron, but in other respects the description might be used to-day. If we "set the work transhaw and transiring from the blast" we get certain kinds of iron which the yard-grader knows, by the grace of God, but which may or may not be what is needed at the foundry. If the spirit of Dud Dudley could make the rounds with a pig iron breaker and grader he would feel perfectly at home and would rejoice that the art which

he founded in England 260 years ago had not progressed much beyond its original lines. Dudley had three grades of iron—gray, mottled and white. We have 13 grades regularly and as many more as may be necessary to confuse the purchaser.

On the yard and without any help, other than is given by his own experience, the grader distinguishes between the following kinds of iron, to wit: Open silver gray, close silver gray, No. 1 soft, No. 2 soft, No. 1 foundry, No. 2 foundry, No. 3 foundry, No. 4 foundry, gray forge, mottled, white. If he needs other grades he makes them as he goes along, so that instead of being annoyed at the absurdity of the performance, we ought to be thankful that he stops with 13. The first eight are grouped under the term "foundry irons," while gray forge, mottled and white are known as "mill irons."

VARIOUS GRADES DEFINED.

The grader will tell you that the silvery irons are silvery irons; that they have a fine, silvery luster on the fresh face and are flaky, that they have little or no granulation and are weak in fracture, and that they carry from five to six per cent of silicon. He will tell you that they are the "hottest" irons, "the work being set transhaw and transiring from the blast," and that they contain very little combined carbon, about the only thing at present which is not controlled by a trust, although it certainly is in a combination. He will then go on to tell you that the soft irons begin to show granulation, that the color is light, the face smooth and the fracture weak, and that the silicon is from three to four per cent. They are not as flaky as the silvery irons, nor so jagged as the foundry irons, and the darker color is due to graphitic carbon.

In No. 1 foundry the color is dark, the granulation very open and regular, the crystallization is well marked and the face is rough to the feel. The silicon is from 2.50 to 3.0 per cent, while the proportion of graphitic carbon is considerably larger than in the soft irons. No. 2 foundry differs from No. 1 in having a closer grain and a finer crystallization, the color may be as dark as in No. 1, but there is lacking a blackish-gray, velvety color

which is always present in the other grade. The silicon may be from 2.25 to 2.50 per cent. And so on with No. 3 and No. 4 foundry, these containing, respectively, 2.0 to 2.25 and 1.75 to 2.0 per cent of silicon. Gray forge contains from 1.50 to 1.75 per cent of silicon and has a pebbled granulation in the center, with mottled edges. The face is blistered and pitted and is often honeycombed. Mottled iron has from 1.25 to 1.50 per cent of silicon, no granulation, and shows a pepper-and-salt appearance on the fresh face. White iron has no granulation at all and is often as white as bleached linen, but is not silvery.

After some years of intimate connection with this system of grading, I have reached the conclusion that, as a rule, the graders are very conscientious in applying the knowledge gained on the yard and that no better results can be expected under any exclusively yard system than are found at present. The objection to the system is that it is radically wrong in principle, not in administration. Given the principles now governing it and it will be found that they are faithfully carried out. The question is not whether better results can be had under the present system, but whether the present system is not wrong. It is granted that the present grading is carried out as well as it can be, but this is no more than saying that the wooden plough with a yearling at one end and a stripling at the other does as well as can be expected. The wooden plough may only scratch the surface, but this is all that it is expected to do, and those who would sub-soil with it are destined to many disappointments. So it is with the system of yard-grading now in use; it does as well as can be expected of it.

The tendency of the trade is now strongly towards a closer chemical inspection of the irons offered for sale; and the grader who intends to keep up with his profession must take this fact into consideration. He must acquaint himself with the effect of the chief constituents upon the various irons in respect of color, granulation, fracture and face. He is called upon to decide questions involving a great deal of money, and as it may happen that he cannot wait for an analysis he must be prepared to grade with-

out it. He should, by all means, cultivate the closest intimacy with the laboratory, have the various grades analyzed as often as possible, and not neglect to inform himself as to the influence of the burden, heat and pressure upon the product under his care. But when this is done and after he has repeatedly standardized his eyes it is impossible for him to grade accurately unless the furnace is running uniformly. It is in this respect that furnaces so situated as to be able to buy large stocks ahead and run for months on almost the same ore, fuel and stone possess many advantages over those that live, so to speak, from hand to mouth, and take what they can get.

LOWER SILICON THE RULE.

Let us take a district in which is produced about one-third of the foundry, pipe and mill irons made in the United States. I do not speak of the steel trade at all, for the system of grading irons for steel making is altogether different. Any one at all familiar with the district referred to knows that it has become difficult to make soft irons there. The old analyses of 4.50, 5.0 and 5.50 silicon are rare, the silvery irons are conspicuous by their absence, while No. 2 soft has dropped back into the position formerly occupied by No. 1 soft; and No. 1 soft is often found with the silicon of No. 3 foundry. The irons that formerly carried from three to five per cent of silicon now carry from two to three per cent, and this, too, without having suffered any notable change in appearance. Perhaps it would be fairer to say that the changes in appearance by which the grader is guided are not of such a nature as to enable him to sieze upon and use for his purposes. Be the explanation what it may, the conscientious grader is brought to face this practical difficulty—the former high silicon irons have changed their composition without having changed their appearance correspondingly. An iron that looks like No. 2 soft, or No. 1 soft, and which, according to ordinary yard grading, would be classed as such, is found to contain less than 2.50 per cent of silicon, and may contain only 2.0 per cent. The writer has known instances where a certain iron, graded by two competent men as soft, really had less than

two per cent of silicon, and could not have been sold as soft iron.

In a certain district in this country, it was stated by the manager of the furnaces 10 years ago that No. 1 foundry carried 3.66 per cent of silicon, No. 1 mill, which was also known as No. 3 foundry, carried 2.87, and No. 2 C (a silvery iron), as much as 7.09. In this same district there has been a complete change in the composition of the irons, and yet the same absurd system of nomenclature is employed, without regard to the fact that it no longer applies. Ordinarily and when grading from the same furnace running on about the same burden, etc., the competent grader comes very near the proper grade, and may be trusted to ship on his own judgment. But when complaints arise, and we are all familiar with this phase of the perversity of human nature, the consumer must be shown that the iron that he objected to as not being No. 3 foundry, for instance, does really contain from 1.75 to 2 per cent of silicon, irrespective of its appearance. This much as to silicon. But how is it when it comes to graphitic and combined carbon? Is the iron to be graded solely by its silicon content? It is granted that, for the most part, iron can be fairly well graded on its content of silicon, and that this element confers upon the iron peculiarities of color, granulation, fracture and face that are more strongly marked than peculiaraties due to other ingredients. It is this fact that has rendered possible the present system of visual and tactual grading. It was quietly assumed that if the silicon was all right the iron was all right, and, as it is a poor rule that will not work both ways, if the iron was all right the silicon was all right.

SILICON THE BASIS.

The easiest way of grading iron is by its silicon content, but it by no means follows that it is the best way. Disregarding the content of sulphur, as not seriously affecting any of the grades above gray forge, it seems to me that there should be certain ratios established between silicon and combined carbon, or between silicon and graphitic carbon, for the soft and foundry irons. The variation in the amount of silicon does, of course, influence the quality of the iron, and one might go even further and say it

influences the iron more than any other single ingredient. But combined carbon is by no means to be neglected. In 29 complete analyses of iron graded as No. 3 foundry, the writer found that the silicon varied from 1.45 to 3.83, the average being 2.37. Five of the samples should have been graded as No. 1 soft, as the silicon was between 3.04 and 3.17, and one should have been No. 2 soft, with silicon 3.83. These irons were all graded on the yard by a careful and competent man, yet in six cases out of 29, or 20.7 per cent, the iron graded as No. 3 foundry was really soft iron. Excluding these six, the average silicon in the other 23 was 2.16 per cent, a result not far wrong, as No. 3 foundry may contain from 1.90 to 2.20 per cent of silicon. Now, in the six cases that gave silicon much above the normal amount for No. 3 foundry iron, the combined carbon was over one per cent, while in the irons that could have been shipped as No. 3 foundry, the combined carbon was about 0.85. The combined carbon in No. 3 foundry does not usually run as high as 0.85, the average being about 0.40 per cent. But when the soft iron resembles in appearance the foundry irons it will generally be found that the combined carbon is high. We have then to discriminate between soft irons with over three per cent of silicon and the normal amount of combined carbon, and irons which contain over three per cent of silicon and over one per cent of combined carbon. Grading on fracture and appearance, some of these latter irons would be put in No. 3 foundry; grading on silicon content they would go into soft iron, with the understanding that the combined carbon was abnormally high.

The same principle holds good with respect to the other foundry irons, although in a less degree. It is the tendency of the lower grades of foundry irons to show a higher percentage of combined carbon than is usually the case that renders grading by fracture, etc., uncertain. In case of doubt, a silicon estimation will enable one to decide whether or no the iron should be put in the soft grades, and an estimation of combined carbon would decide whether or no it should be stated that this element is above the average.

The purpose to which pig iron is put depends absolutely upon its composition; the color, fracture, granulation, and face have nothing to do with it except in so far as they indicate the existence of certain ingredients in certain quantities, whose actual amounts can be determined only by the chemist. As regards grading on the yard, the inferences to be drawn are reliable only if confirmed in the laboratory, and the sole question is whether or no chemical composition so affects the physical appearance of pig iron as to enable us to grade it without recourse to the chemist. Now, it is conceded that with uniform stock and uniform practice at the furnace a good grader will come very near to the chemical composition. We may allow that he comes sufficiently near for the difference not to be appreciable when the iron is used in the mill, the foundry and the pipe works. But fully one-third of the iron for such purposes is made under conditions that do not allow of uniform stock, and without uniform stock there cannot be uniform practice, and we are compelled to fall back upon the laboratory.

Furthermore, I am convinced that if foundries would pay more attention to the composition of the irons they buy there would be less complaint in the trade generally. We are coming to understand that there may be and often is a wide variation in the composition of foundry irons, and that when a shipment is purchased as foundry iron there may be all sorts of things in it. Many curious discrepancies in the results from using so-called foundry irons are due to the fact that there was nothing known about the iron in the first place except that it was foundry iron, and the term is a very illusive one.

PROPOSED IMPROVEMENTS IN GRADING.

What changes are to be suggested by which not only the sale but also the use of pig iron could be largely helped? The present system is open to such an array of objections that it does not seem to be necessary to discuss it further. But if it is to be changed, what form should it assume? Almost any one can tear down a structure, but unless he has something to suggest in place of it he cannot be said to have done much good.

I would suggest that instead of the present 13 grades, there be used only six, and that in grading iron into the three elements of silicon, combined carbon and sulphur be used, with the understanding that for certain purposes the phosphorus also be included. These six grades might be as follows:

	Silicon.	Combined Carbon.	Sulphur.
Silvery irons	5 to 6	0.10 to 0.30	0.01 to 0.04
Soft irons	3 to 5	0.20 to 0.60	0.01 to 0.05
Foundry irons	2 to 3	0.30 to 0.90	0.01 to 0.07
Gray forge	1 to 2	0.40 to 1.25	0.04 to 0.09
Mottled	0.6 to 1	0.50 to 1.80	0.06 to 0.11
White	0.1 to 0.6	1 to 2.50	0.08 to 0.30

This scheme, or some modification of it in line with its general provisions, would retain the present nomenclature, and bring it into closer accord with laboratory results. It would do away with five grades, which are no more than side-grades at best, and would enable the grader to exercise better judgment on the yard. The rapidity and accuracy with which silicon estimations are now made leaves very little to be desired, and the same may be said of sulphur and combined carbon, for such purposes as are here indicated. The main thing is to make a start in this direction, and the details of the analytical methods to be adopted can be settled afterwards. It is not required that for such material the methods should have the same degree of refinement as is required in the steel trade, where the effct of very small variations in the amounts of certain ingredients is strongly marked. We are dealing with a rougher class of material in which there can be allowed a longer swing of the pendulum. In the steel trade it is now recognized that methods of analysis must be based as far as possible upon the nature of the metal under examination. A method which gives good results on crucible steel does not necessarily apply to Bessemer or to open-hearth steel. It would not be a matter of great difficulty to devise methods for the examination of pig iron intended for foundries, or mills or pipe works. If foundrymen generally should make up their minds

to purchase pig iron on analysis it would not be long before the producers of this kind of material would have to fall into the plan with a method of examination that would be acceptable.

It is a noteworthy circumstance in connection with this matter that the very kind of iron on which some of our Southern friends are basing the highest hopes, basic iron for the manufacture of steel, has been sold from the very beginning on analysis, the specifications being so drawn that a rigid inspection of it was demanded. It has come into use on a large scale, and justly so, for it is an excellent material for its purpose, and the present steel works building near Birmingham, Ala., could never have been undertaken had it not been shown that this kind of iron could be made there. Finding that the trade in foundry, mill and pipe iron was not altogether as much as they wanted, they propose to make steel and to make it from the very iron that has always been sold on analysis. In common with most makers of foundry irons, they have declined to sell foundry iron on analysis, but when they found that they could sell basic iron only on analysis they gladly entered into the business. In other words, the steel men in the country are ahead of the foundrymen in that they can and do get iron on specifications as to composition, and the only reason why foundrymen have not been able to do this is because they have not demanded it.

IMPROVEMENT BEGINS AT THE FOUNDRY.

It seems to me that in some respects we have gone at the improvement of foundry practice from the wrong end. We are trying to study the iron after it leaves the foundry, while it is quite as important to study it before it reaches the foundry. A great mass of information has been acquired as to this point and that point in castings, but the foundation of the whole thing is left to take care of itself, and foundry iron is foundry iron, no matter whether the silicon is 3.50 or 1.50 per cent. If some of the attention now being given to castings were given to pig iron before it gets into the castings, I believe we would make great strides towards a better understanding of the art of founding.

Some years ago, in connection with the inspection of the reg-

ular make of foundry iron at an establishment where I was employed as consulting chemist, the following plan for keeping track of samples was devised. It was used for a long time with the happiest results, but finally fell into disuse because it was impossible to interest the management in the importance of the subject. But while it was used we certainly got to know a great deal more about the iron than was ever known before. We had stout manila envelopes prepared 3x6 inches in size. On front was printed the following:

.... Company.
.....tons of..... Grade.
Made .....in No..... Furnace.
Sampled ..... by .....

(Mark out the word that does not apply.)

Color { Light. / Dark. } Fracture { Weak. / Strong. } Face { Smooth. / Pitted. / Blistered.
Chilled edge.....
Granulation { Regular / Irregular. } { Fine. / Medium / Coarse. }

On the back of the envelope was printed a form for recording the burden, heat, pressure of blast and revolutions of the engines corresponding to the pig iron that was sampled. The samples were sent in to the laboratory and analyzed, and a report made to the management, to the furnace superintendent and to the grader on blanks corresponding to the envelopes. In this way a great deal of valuable information was secured at a minimum expenditure of time and labor. The composition of the irons was observed according to the furnace practice, and the original yard-grading was checked by actual results in the laboratory under a system that allowed of very close inspection of the iron.

The envelopes were prepared after many consultations with the chief grader and others interested in the accurate grading of iron for commercial purposes. We recognized the fact that in yard-grading it was necessary to take careful note of color, fracture, granulation and face, whether the color was light or dark,

the fracture weak or strong, the granulation regular or irregular, and whether fine, medium or coarse under each of these divisions, whether the face was smooth, pitted or blistered, and finally whether there was a chilled edge on the iron or not. After receiving the analysis the grader was in position to know a great deal more about the iron than he could have known before, for he standardized his eyes by actual laboratory returns and in a methodical and scientific manner.

A closer inspection of foundry irons is second in importance to no other consideration that can affect the business. The work on standard test bars is of no greater importance than this, and it is earnestly suggested that some steps be taken by this association, and later by the National Association, towards the purchase of foundry iron on analysis.

PROCEEDINGS OF THE WESTERN FOUNDRYMEN'S ASSOCIATION.

The regular monthly meeting of the Western Foundrymen's Association was held at the Great Northern Hotel, Chicago, Wednesday, December 21, at 7:30 p. m. The attendance was small, owing to the inclement weather and the proximity of the hoildays.

The regular order for the evening was the reading of the following paper by Max H. Wickhorst, engineer of tests, C. B. & Q. R. R., Aurora, Ill., on "Porous Castings and Occluded Gases."

Porosity and blow holes in iron, steel, brass and bonze castings, are generally due to occluded gas. To start with, I will explain somewhat fully what occluded gas is. Various molten metals, such as copper, silver, iron, have the power of dissolving different gases, such as hydrogen, sulphur dioxide and carbonic monoxide. These gases dissolve in the molten metal just as air dissolves in water. If a glass of water is drawn and allowed to stand in a warm place, the air bubbles will collect along the sides of the glass, and if water is frozen the ice formed will contain air bubbles, due to the dissolved or "occluded" air liberating itself at the time the water freezes, or sets, or passes from the liquid to the solid state. So, also, if molten metal contains occluded gas, the gas shows no tendency to escape while the metal is in the molten condition; but as soon as the metal starts to set, the gas starts to liberate itself and assumes the gaseous state, forming air bubbles or blow holes throughout the mass.

The gases which may be occluded, or dissolved, in molten metals, are hydrogen, sulphur dioxide and carbon monoxide. The two other gases which are generally present when metals are melted, namely, carbon dioxide or carbonic acid gas, and water vapor, probably do not dissolve in molten metals.

HYDROGEN INTRODUCED IN CASTING BRASS AND BRONZE.

Brass and bronze are most frequently rendered porous by hydrogen; bronze containing little or no zinc being specially liable to be defective from this gas. Hydrogen is a very light, inflam-

mable gas. It weighs only about one-fourteenth as much as an equal volume of air. It is very inflammable, and is an important constituent of the fuel gas known as "water gas." The product of its combustion in air is water. The hydrogen gets into the metal by the decomposition of the water of the mold, when the metal is poured too hot. Water is a liquid formed by the chemical union of the two gases hydrogen and oxygen, in the proportion of two volumes of hydrogen to one of oxygen, its formula being H^2 O. Water is liquid at ordinary temperatures, and becomes a vapor at 212 degrees F.

When bronze is poured into a green sand mold much above the proper temperature, the metal does not set right away but remains liquid in the mold. It decomposes the water of the mold, separating the water into its constituent elements, oxygen and hydrogen. The metal combines with the oxygen, forming oxide. If zinc or aluminum are present, these combine with the oxygen, forming an oxide which comes to the top and separates from the metal. If no deoxidant such as zinc, aluminum or phosphorus is present, the oxygen combines with the copper, forming oxide of copper, which remains mixed with the rest of the metal, and in the fracture of such metal it forms red and green colored spots.

The hydrogen of the decomposed water, however, does not form any chemical combination with the metal. But the molten metal dissolves it very readily, the hydrogen being absorbed without having its chemical nature changed. While the metal is still molten the hydrogen remains quietly in the metal, but as soon as the metal begins to set, the hydrogen tries to liberate itself, going back into the gaseous state and forming bubbles throughout the mass, and causing a porous casting. Such porosity does not show itself on the surface of the casting, but can be seen only by machining off the skin, or chipping into it, thus getting into the body of the metal. This is as would be expected, since gas bubbles start to form only after the skin is set.

Brass and bronze containing fluxes such as zinc, aluminum, manganese or silicon are not apt to be porous from decomposi-

tion of the water of the mold, since the skin of oxide which these form as soon as air gets at the metal, forms a lining along the inside of the mold which prevents any communication between the molten metal and the moisture in the mold. Bronze which has been fluxed with phosphorus, that is phosphor-bronze, however, is very apt to be rendered porous due to hydrogen obtained by decomposition of the water of the mold. Phosphorus combines with air or oxygen, going off in the form of a white smoke, and leaves the surface of the metal perfectly clean. The molten metal and the moisture of the mold come in direct contact, with the result that the moisture is decomposed, the oxygen combining with some phosphorus going off as white smoke and the hydrogen becoming occluded and afterwards causing porosity. This is a result which is actually frequently the case where phosphor-bronze is poured at too high a heat. To corroborate the above explanation of the metal decomposing the water of the mold, and thus introducing hydrogen into the metal, I have made the following experiment: Melt about 50 lbs. of phosphor bronze, composed of about 10 per cent tin, one-half per cent phosphorus and the rest copper, and get it very hot. Pour a small casting with this, say a two-inch round rod, six inches long, in a green sand mold. The metal will remain quietly in the mold a short time, but after one or two minutes it will start to rise back through the gate, due to the hydrogen which had been absorbed liberating itself, assuming the form of bubbles and thus taking up more room. And the metal is then of necessity forced back through the gate. If this casting be broken when cool, it will be found to be porous, and the gate, especially, will be honeycombed.

After pouring the first casting, pour a little of the metal into an iron ingot mold and when this has cooled sufficiently, cool off the metal in the crucible by stirring the cooled ingot into it till it has been cooled down to a proper pouring temperature. Then pour another casting similar to the first in every respect, and it will be found that the metal runs into the mold quietly and remains there. When this casting is broken it will be sound. This experiment proves that merely getting the metal very hot does

not spoil it for making good castings, but that when poured at this high temperature, a reaction goes on with the materials of the mold which produces the bad result, as regards porosity.

HYDROGEN PRESENT IN THE INGOTS.

The foregoing deals with the presence of hydrogen due to faulty handling of the metal by the molder. Most of the phosphor-bronze used is bought in ingot form, and a great deal of the material on the market is already defective from the presence of occluded hydrogen, and will give porous castings when used, and the explanation of the presence of hydrogen is as follows: Phosphor-bronze is usually made by melting the copper, tin and lead and then introducing the phosphorus by means of a cup shaped instrument called a retort or phosphorizer. Phosphorus is a wax-like substance and comes in about the shape and size of a candle. It melts at about 110 degrees F., and catches fire with the utmost readiness, so that it has to be kept under water. The phosphorus is put into the retort, either moist or wrapped in moist paper, and the retort then plunged into the molten metal, mouth downward. The phosphorus melts and combines energetically with the metal. The moisture which is present is also decomposed in the presence of the molten metal and the high heat. The oxygen combines with the phosphorus going off as oxide of phosphorus in the form of a white smoke. The hydrogen dissolves in the molten metal and when the metal is poured into ingots it cools so rapidly that the gas has no chance to escape, but remains fairly evenly diffused throughout the ingot. Whether an ingot is defective from the presence of occluded gas, can be told by the appearance of its upper or open surface. An ingot free from occluded gas will have its upper surface concave and shrunken in, and may even be somewhat cracked due to shrinkage. Another ingot, however, containing occluded gas will have a convex surface and be bulged out. This is because the gas, while the ingot is cooling, makes an attempt to get away, and in doing so bulges out the ingot.

The introduction of gas into phosphor-bronze in the manufacture may be avoided by having the phosphorus perfectly dry.

As ordinary phosphorus cannot be dried without danger of igniting, the phosphorus is first put into a diulte solution of sulphate of copper or blue vitriol for half an hour or longer. This deposits a coating of copper on the phosphorus which allows it to be dried without danger of igniting, so long as the copper coating remains intact.

I read a paper before the Western Foundrymen's Association in March, 1897, which explains in detail the manufacture of phosphor-bronze. Phosphor-bronze made with dried phosphorus will not contain any occluded gas.

ACTION OF OCCLUDED GAS IN PHOSPHOR-BRONZE BEARING METAL.

In phosphor-bronze metal the effect of occluded gas is detrimental and serious in that it causes hard spots in places in the metal. This metal has usually the following composition: Copper, 79.3 per cent; tin, 10.0 per cent; lead, 10.0 per cent; phosphorus, .7 per cent.

In this mixture, the tin combines chemically with some of the copper, forming a copper-tin compound, which is gray in color, very hard and has a low melting point. The bronze therefore contains no free uncombined tin. The lead forms no chemical combination but remains simply mixed with the rest of the ingredients. The phosphorus probably combines with the lead to make phosphide of lead. The excess of copper not necessary to combine with the tin remains as free uncombined copper.

So that in the crucible, the molten metal consists of free uncombined copper, copper-tin compound, lead and phosphide of lead. When bearing phosphor-bronze which contains considerable occluded hydrogen gas in cast, it flows into the mold quietly and remains quiet for about one or two minutes. If the gate of the casting be watched it will be noticed that after about two minutes, little beads of metal, with the appearance of melted lead, come oozing through the top crust of the gate and stand there like drops of sweat. These beads are very hard and cannot be filed, and are gray in color. If the casting be now cleaned, nothing peculiar can be seen on its surface, but if the top of the casting be chipped into, or the skin machined off, or the casting

broken in two, it will be noticed that the casting is porous and full of blow-holes. If the gate be broken in two this will be specially honeycombed. If the fracture be examined it will be noticed that the gas cavities are all bright yellow, and that the gray portions of the copper-tin compound and the lead are perfectly sound and solid. This shows that it is the free copper in the bronze which dissolves or occludes the gas. After the metal had been poured, the constituent copper started to set first, it having the highest melting point, leaving the copper-tin compound and the lead still liquid.

While the uncombined copper is setting, it liberates the occluded gas, and this in trying to get away, forces the still liquid copper-tin compound and the lead ahead of it, and causing the beads to come out through the gate. I have analyzed some beads obtained as above described from a bearing metal phosphor-bronze of the above composition, with the following results:

	Bead.	Body of Bronze about
Copper	74.66%	79.5%
Tin	22.15%	10.0%
Lead	3.06%	10.0%
Phosphorus	.37%	.5%

It will be noticed that these beads consist practically of a copper-tin compound, this having taken along with it some lead and some phosphide of lead. There is not much lead present, probably because as lead mixes only to a small extent with the other materials and is much heavier it settles away and remains behind. If an engine driving brass be broken it will be noticed that although most of the bubbles collect near the top of the casting, some collect near the surface even at the bottom, which is usually the bearing face. As the gas in collecting into bubbles pushes the hard copper-tin compound ahead of it, as we have seen above, hard spots form in the brass. As the hard spot takes all the weight of the bearing, excessive friction is created and a hot brass ensues.

METHOD OF GETTING RID OF OCCLUDED GAS IN INGOTS.

Occluded hydrogen in ingot metal can be expelled by introducing oxygen or air into the molten metal, thus oxidizing out the hydrogen.

This can be done only by first oxidizing out all the phosphorus, as this takes the oxygen first. This experiment may be made to demonstrate the principle involved. Melt about 70 lbs. of phosphor-bronze, which has given trouble from occluded gas, and pour a casting from it. This will show that this particular heat is so defective. Then place back in the fire and when melted add sufficient oxide of copper to oxidize all the phosphorus and still have a slight excess left. Then re-phosphorize the metal and add enough lead and tin for the copper introduced and pour another casting. This will be found to be sound and free from porosity. I have made an experiment similar to the above, and while the original metal gave a very porous casting, the metal after treatment gave a perfectly sound casting. Commercially, this method, or any method involving the same principle, would not be practicable on account of the expense, and probably the best way to dispose of such metal, if one has such metal on hand, would be to mix it with enough good metal and use it where a slight porosity will do no harm.

SULPHUR DIOXIDE GAS.

So far I have been dealing with hydrogen gas. Another gas which frequently causes porosity in brass castings is sulphur dioxide gas, chemical formula of which is SO^2: It is a gas of pungent ordor, being the same gas which is formed when sulphur burns, and is used for fumigating purposes. It is also sometimes used in refrigerating machines. The different metals which go to make up brass may all contain sulphur. When brass is made of some metal containing sulphur, as soon as the metal comes in contact with air sulphur combines with oyxgen of the air, forming sulphur dioxide gas, which then acts in all respects similar to hydrogen. As I have already expanded somewhat fully on how hydrogen acts, it will not be necessary to explain further about the action of sulphur dioxide gas. I was foreman of the brass

foundry of the C., B. & Q. R. R. for a while, and not long after taking charge of the foundry we had one or two heats of small miscellaneous brass castings show porosity when the casting was broken.

The brass consisted of copper, zinc, lead and tin. On looking over the list of materials used, it seemed probable that the trouble lay in the zinc containing sulphur. The zinc used consisted of old worn out battery zincs which had been melted up under charcoal and cast into small ingots. Now old zincs have considerable sulphate of zinc adhering to them, and when this is heated under charcoal, some of it is reduced to sulphate of zinc, which remains in the metal. When the metal is melted and poured containing such zinc, the air acting upon it, the sulphur has a chance to combine with some oxygen, forming sulphur dioxide and acting as before explained The zinc was then separately melted without any covering of charcoal, exposing it freely to the air, and then recast into ingots. When only a limited amount of air combines with the sulphur, sulphur dioxide is formed, going off as gas, as probably zinc does not occulde this gas. When this retreated zinc was used, the castings were perfectly sound without any porosity.

CARBONIC OXIDE OR COAL GAS IN STEEL.

Carbonic oxide or coal gas has a chemical foramula CO. This gas is also a constituent of "water gas." It is an inflammable gas, burning with a hot light blue flame. It is odorless but very poisonous. It is the poisonous gas given out by hard coal stoves, known as coal gas.

As far as my observation goes, brass and bronze are not liable to be defective because of this gas, as I have not seen a case whose porosity could be positively attributed to it. The porosity of steel castings, however, seems to be frequently due to carbonic monoxide gas. When a heat of steel has been heated till the carbon is low and the silicon reduced below a certain point, the castings made from such a heat are apt to be filled with holes. The explanation for this seems to be that as long as silicon and manganese are present these combine with oxygen and remove it entirely

from the metal. As soon as these are reduced very low, some of the oxygen combines with the carbon forming carbon monoxide gas, which then renders the metal "lively." If now a little aluminum is added this takes the oxygen and the metal is again made "dead." I am not a steel man and would hardly be bold enough to offer any theory concerning steel, if it were not for the fact that there is practically no literature on this occluded gas question, and also that what stray statements one may run across on this subject, show that the author generally has a wrong idea of the nature of the action of occluded gases. For instance: Campbell in his book on Structural Steel, in the chapter on steel castings, page 373, in speaking of aluminum and silicon versus manganese, says: "Another function which may play a part in the operation is the increase in capacity to dissolve or occlude gases, and as far as the value of the casting is concerned, this will be equivalent to destroying them." The idea evidently being that the aluminum or silicon has such an effect on the gas that when the metal passes from the liquid to the solid state, the gas likewise goes from the liquid to the solid state. We have seen, however, that when metal contains dissolved gas, the gas goes from the liquid to the gaseous state as the metal solidifies.

DISCUSSION.

L. L. Smith, foreman C. B. & Q. R. R. brass foundry (Contributed): The paper of Mr. Wickhorst treats of a subject which so far as I have been able to discover is practically untouched in metallurgical literature. Considering the importance of the phenomenon of occluded gases and the opportunities of gases for giving trouble, especially in alloys of copper, the fact that the subject has received so little attention from metallurgical writers is somewhat surprising. In the refining of copper, the operation of poling makes very manifest the possibility of gas being occluded. When the copper has reached the stage when it is to be purified by poling, the metal is practically free from metallic impurities, but it contains oxygen in the form of cuprous oxide which is held in solution in the metal. To reduce this cuprous

oxide to metallic copper, the surface of the molten mass is covered with a layer of charcoal, and a green sapling or pole is plunged into the metal. The gases given off by the burning pole causes the copper to bubble and sputter violently. The gases, in permeating the metallic mass, come in contact with all parts of the copper and assist in reducing the cuprous oxide. If the poling has not continued long enough, a portion of the oxide remains unreduced, the copper is said to be "under-poled," and a test ingot dipped out will show upon cooling a concave upper surface. If, however, the poling has been carried on beyond a point where the oxides have all been reduced, the gases having no oxygen to combine with will be occluded by the copper. The metal in this condition is said to have been "over-poled." A test ingot upon cooling will show a convex upper surface due to that peculiarity of copper which in the molten state has occluded gas and upon cooling has released it in bubbles which cause the ingot to swell.

I recently had occasion to melt some copper which had occluded sulphur dioxide, and upon being poured out into an ingot mold, the upper surface of the ingot swelled up like the top of a loaf of bread.

In copper refining, the cure for over-poling is quite simple, the copper being allowed to reoxidize, after which it is repoled up to the proper point. After copper has entered an alloy such as phosphor-bronze, if the bronze having been deoxidized by phosphorus occludes gas, the gas cannot be so simply eradicated as with copper in the refining furnace. As indicated in Mr. Wickhorst's paper, the alloy can be reoxidized by adding cuprous oxide, and again deoxidized by phosphorus, but this, as he points out, is a somewhat expensive process. A description of some inexpensive commercially practiced method of getting rid of occluded gases will certainly form a welcome addition to metallurgical literature. It is best, however, to seek means of preventing the occlusion of gas, for in this case, as in many others, "an ounce of prevention is worth a pound of cure."

An informal discussion of the paper was had, and Mr. Wickhorst gave a very interesting general talk on the manufacture

of brass and bronze castings. It was decided to have the paper presented before the January meeting of the association, to give absent members a chance to hear and discuss it. The meeting then adjourned.

A REVIEW OF THE FOUNDRY LITERATURE OF THE MONTH.

AMERICAN MACHINIST.

DECEMBER 1st.

Mr. C. Vickers tells his experience in casting wrought iron. Cast wrought iron is a new phrase, even to most foundrymen, but it would seem that it is quite practicable to melt and cast this metal into articles of almost any dimensions. The methods pursued are very much the same as those employed in making brass or steel castings by the crucible process. The molds, for light work, were made in green sand, sometimes skin-dried, to give a finer surface to the castings; but for heavy work, they were dired in the oven. By melting in six pots at once he was able to cast a 500-pound piece. The castings produced were as easily weldable as bars of rolled wrought iron.

DECEMBER 8th.

L. C. Jewett, writing upon "Coremakers and Their Environments," deplores the inadequate facilities and the uncomfortable conditions that attend coremaking in most foundries. Coreplates should be planed, in order to insure straight cores. The oven should be thoroughly well made, with good draught, and provided with dampers that can be manipulated from the outside, and everything possible should be provided for the comfort and convenience of the workmen, all which would result in increased profit to the employer.

DECEMBER 15th.

An article by John M. Richardson tells young pattern-makers how they may discover defects in patterns by the marks and blemishes found on the patterns when returned from the foundry. Another, by the same writer, illustrates a plan for making open frame core boxes.

DECEMBER 22nd.

Thomas Wathry describes a method of casting sash weights in iron molds. The iron molds, or "chills," have hollow backs through which a current of water flows, so that the casting pro-

cess may be repeated in them at intervals sufficient to permit solidification. The molds stand vertically, and the two halves are hinged together at the lower end, and the upper end is fastened by a simple, quick acting device. The pouring is kept up for four or five hours, resulting in a product of 20 tons of sash weights. The molds are said to last, with fair usage, from 18 months to 3 years.

DECEMBER 29th.

The manufacture of shell for the United States Navy is described by Rudolph E. Bruckner, M. E.

The manufacture of shells requires great exactness, and the facilities in ordinary shops are inadequate for the purpose. The cast iron must be able to stand a pull of 23,000 pounds per square inch. A sectional view of the mold is given, showing how the shells are cast, two in a flask. The article is quite lengthy, and nine figures are employed to illustrate the processes in molding, etc.

IRON TRADE REVIEW.

DECEMBER 1st.

"Making of Gun Iron and Semi-Steel" is the title of a 4-column article by Titus Ulke, M. E. In this are given four different mixtures of iron which have a tensile strength per square inch of from 30,000 to 34,700 pounds. The chemical contents of the various ingredient irons are also given. Mr. Ulke says that * * * "In the manufacture of United States gun and mortar carriages, gun iron, designated as cast iron No. 2, or its accepted equivalent, semi-steel, is largely used. The material thus employed must fulfill the requirements of the following specifications: It shall represent a high quality cast iron known as charcoal iron (the specifications should here be amended to include semi-steel, as this material is accepted as cast iron No. 2 by the Ordnance Department, although it is not necessarily a charcoal iron) prepared in an air furnace or by such other process as will give an elongation of not less than 0.25 of one per cent under stress before rupture.

"To test this elongation, separate cylinders 20 inches long by 9 inches diameter, with a 2½-inch axial core, should be taken, one from each ladle of cupola iron, so as to represent fairly the iron in the casting itself. From these cylinders specimens shall be prepared with stems 10 inches long by 1.129 inches diameter."

These are in addition to the test pieces for determining tensile strength, whose stems are 1.129 inches diameter also.

The coupon test piece should be cast tangentially attached to the thickest side of casting. If the casting represented be, say 3½ inches thick, the test piece should be of that diameter, being reduced to 1.129 inches diameter before breaking.

The cast iron No. 2 should show a tensile strength of not less than 28,000 pounds and not more than 39,000 pounds per square inch.

It appears that a test bar of comparatively small section is misleading as an indicator of tensile strength of heavy castings, their exaggeration sometimes reaching to 10,000 pounds.

Mr. Ulke says: "The depth to which the 'chill' penetrates, as determined by special chill-blocks 6x4x1½ inches in size, cast in special molds in the same heat as the pieces, is a good indication of the tensile strength of the semi-steel cast, and serves the foundryman as a simple and convenient guide for grading his Metal. The metal is poured as hot as possible, and both casting and test piece are left completely covered in the sand till cool."

THE FOUNDRY.

An illustrated article on "Core Prints," by John M. Richardson, treats intelligently of this branch of pattern making, giving many valuable hints as to their construction. Mr. Richardson thinks there ought to be a standard length and taper for stock-core prints, thus making them interchangeable from one pattern to another, and insuring correspondence with the cores.

R. D. Moore writes concerning initial strains in ill-proportioned building columns, showing, by the assistance of illustrations, how uniformity of section conduces to the greatest strength, and how disproportion in this respect may cause a casting to crack without being subjected to any external force. He also

illustrates a method which he employed for punching core prints, and setting cores at a considerable angle from the line of pattern-draft.

Wm. Roxborough has an article upon "Feeding, or the Composition of Metals," showing how to prevent shrunk cavities and spongy spots. This article is illustrated with four cuts, of different proportions, calculated to elucidate his argument. Incidentally, disproportion of section is dwelt upon at some length, his contention being in line with that of Mr. Moore, as referred to above.

E. C. Wheeler writes on malleable iron mixtures. There should be a definite point established for correct amounts of each element in malleable iron mixtures. In light work the silicon should be from 1.00 to 1.25, the loss in manipulation being .50 to .60. The total carbon should be 3.50 to 4.00 per cent. For heavy work the silicon should be kept down, in order to give a greater per cent of combined carbon in this class of work.

"Making a large Brass Casting" is the title of an illustrated article by C. Vickers, which is of a character to preclude condensation.

W. J. Keep comments on "Foundrymen and Foundry Tests." The disagreement among those who advoate the use of tests confuses the general foundryman, and makes it difficult for him to employ them to advantage. What is needed is a clear statement of those principles that are essential, and the leaving entirely alone of all that is unnecessary. There are three distinct tests, and any founder can use them:

First. Chemical analysis, knowing the composition of the pig iron producing the desired grade of castings.

Second. Mechanical analysis, by the measure of the shrinkage of a test bar producing the desired grade of castings.

Third. Finding the actual strength of any size of casting by breaking a test bar.

Either of these methods will produce castings of practically the same grade each day. The uniformity of the grade of castings is determined by a variation of silicon, and the test of grade

is the measure of shrinkage. The only way to find the strength of a casting is to break a test bar.

THE TRADESMAN.

DECEMBER 1st.

E. H. Putnam, treating of the subject of repairing the foundry floor, says: * * * In many foundries the repairing is done simply by wetting down the floor heavily and spreading new sand, or clay, on the low places, and ramming it down. * * * The proper way to do this so that it will last is to take a pick and dig down about three inches at the edges, and cleaning away everything within the outlines of the space to be repaired to that depth. Then put in the clay and ram it down, leaving the space level with the balance of the floor, and there will be no cutting up of the edges any more than elsewhere.

December 15: The same writer says, of cast iron: We have the verdict of some people that it is unfit for use in any kind of structural work in large buildings. This, however. is only one side of the question. It is but recently that founders have come to know how to use cast iron scientifically. With proper care in the selection of iron mixtures, and in the molding and casting processes, the results would justify a very different verdict from the above.

There is no danger that cast iron will fall into permanent disrepute as a material for work wherein it is generally desirable, and only in particular features, in occasional instances apparently inadequate. The fact is, we don't know how to use the metal; we have only just begun to study its characteristics, and only comparatively few people are doing even that; but the number of these is being augmented day by day. The torch is freely extended to all who will accept it, and he who shall lose his way and fall into the ditch will have only himself to blame.

STAHL UND EISEN.

THE LIFE OF INGOT MOLDS.

The life of ingot molds, as made in Germany, is discussed by Mr. Simmersbach in an article in "Stahl und Eisen," the highest

authority in the iron industry of Continental Europe. Those of us who know how difficult it is to make acceptable ingot molds will be surprised to see how high the injurious elements are allowed to run in the pig irons used for this purpose on the other side of the water. The silicon is specified at 1.50 to 3.50 per cent; manganese, 0.60 to 1.20 per cent; total carbon, 3.50 to 4.40 per cent; sulphur, not over 0.075; phosphorus, not over 0.120, and copper, not over 0.125. Any arsenic present is classed with the sulphur, as its effect is practically the same.

Copper does not bother us specially in this country, but in Europe it is quite common, even silver occasionally entering into the composition of pig iron. High manganese is claimed to be an advantage, as it helps to eliminate sulphur, which, if anything, would be increased in the remelting by contact with the coke.

The above analyses are for the pig iron allowable in making ingot molds. Here is the normal composition of a good European casting of this class: Silicon, 1.6 to 3.0 per cent; total carbon, 3.3 to 4.4 per cent; manganese, 0.5 to 1.1 per cent; sulphur, not over 0.075 per cent; phosphorus, not over 0.125 per cent, and copper, not over 0.125 per cent. A rather curious claim is made by Mr. Simmersbach when he states that silicon which has been reduced from the lining of the cupola causes trouble in the ingot mold. He attributes this reduction to the effect of overheating, for he finds that sometimes there is more silicon in the casting than there was in the charge. The trouble thus caused is found in the separation of too much graphite and its irregular distribution. The probable cause is not the added silicon, which, by the way, blast furnace men would say came from the ash of the coke and not the lining, but the overheating of the iron. The effect of high sulphur in the coke is quite marked, as it not only gives high sulphur castings, but lowers the total carbon. A case in point being a pig iron with .05 per cent sulphur and 4. per cent total carbon, which came out 0.27 per cent in sulphur and only 2.8 per cent total carbon. Another interesting point is the absorption of phosphorus from the coke under favorable circumstances. As to manganese, Mr. Simmersbach states that a 1 per

cent manganese ingot mold lasts longer than one with 0.5, everything else being equal. Great care must be taken in drying the mold, casting at the proper time and in the proper manner. It takes more skill to cast ingot molds, which have so much to endure in the steel casting house, than ordinary jobbing work. The thickness of the walls of an ingot mold are usually specified by the purchaser. In Germany the practice runs about as follows: A half a ton mold is $2\frac{1}{2}$ inches thick, tapering to 2 inches; one ton, $2\frac{3}{4}$ inches to $2\frac{3}{8}$ inches; two tons, $3\frac{1}{2}$ inches to $3\frac{1}{8}$ inches; three tons, $4\frac{1}{4}$ inches to $3\frac{7}{8}$ inches; six tons, $4\frac{3}{4}$ inches to $4\frac{3}{8}$ inches; ten tons, $5\frac{1}{2}$ inches to $5\frac{1}{8}$ inches; fourteen tons, $7\frac{1}{8}$ inches to $6\frac{3}{4}$ inches.

A subsequent issue of "Stahl und Eisen" contains an additional note on the life of ingot molds, by A. Zugger, who gives the composition used by the famous "Concordia" works in Salzburg: Silicon, 1.27; manganese, 1.29; phosphorus, .147; sulphur, .061; graphite, 3.293, and combined carbon, 0.577. This is charcoal iron and the molds last for 200 to 300 casts. A patented process for overcoming the frequent cracking of ingot molds at the lower end is described, a series of wire loops being cast into the mold which is thickest at this place. This plan is said to be very efficacious, especially in small molds.

XUM